PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

Pakistan Journal of Nutrition 10 (2): 195-199, 2011
ISSN 1680-5194

Development of New Convenient Recipes from Local Sudanese Fruits and Vegetables

Nawal Abdel-Gayoum Abdel-Rahman[1],
Mazaher Abdel-Rahim Mohammed[2] and Mona Mohammed Mustafa[3]
[1]Department of Fruits and Vegetables Technology,
[2]Department of Food Chemistry and Nutrition, [3]Department of Microbiology
Food Research Centre, P.O. Box 213, Khartoum North, Sudan

Abstract: The purpose of this study was to prepare and formulated ready to use snack meal (paste) for school children from some local Sudanese common fruits, mango (*Mangifera indica*); forest fruits, baobab (*Adansonia digitata*) and godeim (*Grewia tenax*); also, vegetables, pumpkin (*Telfairia occidentalis*). In addition, the physico-chemical properties, storage stability and sensory quality of the product was evaluated. The results showed that the fruit paste contains high level of protein (19.36%), carbohydrates (64.25%), vitamin C (575.06 mg/100 g) and energy value (365.24 kcal). The fruit paste is containing abundant amounts of potassium and magnesium, excellent quantities of iron, calcium and phosphorous, while, its poor source for sodium for school age children from 4-17 years. The product is kindly stable during storage for 12 months at ambient temperature. However, the product is acceptable for sensory attributes as compare to control sample.

Key words: Local fruits, forest fruits, snack foods, school children, nutrients, energy

INTRODUCTION

Growing children still need plenty of energy and nutrient dense foods. As they have small stomachs and large energy needs, their meals to be more frequent and regular than an adults. The school years before adolescence represent a time of gradual, steady growth and nutritional risks are lower at this time than during the pre-school years and later during the adolescent growth spurt (VS, 2010).

In most developing countries the prevalence of under nutrition and micronutrient deficiencies is high among children. The diets commonly fed to them do mot contain enough energy and micronutrient to meet daily requirements. Children and adolescents grow rabidly, so they require high nutritive diet to satisfy their needs. They need an adequate amount of energy and protein as well as vitamins and minerals, especially iron, calcium and vitamins A, C and D. School children who did have a middy meal at home; they should have an access to snack foods (WHO, 2003). Children in Sudan as in many developing countries, suffer from chronic and acute protein-energy malnutrition diseases that constitute a major problem (ISHS, 2002). Generally, accepted recommendations for improving and covering these needs of school children are to feed them locally available rich micronutrient. Oyeleke *et al.* (1985) mentioned that for production of baby food, all ingredients should be locally available and acceptable to the parents of young children.

Some Sudanese fruits and vegetables varieties will be utilized in fortification of some convenient foods such as baby foods, puddings and ready to use soups and paste. Mango (*Mangifera indica L.*) is a very popular fruit grown in the tropical regions (Berez *et al.*, 2005). This fruit is relished for its succulence, exotic flavour, delicious taste and nutritional value (Abdel-Rahman *et al.*, 2009). On the other hand, mango fruits are rich in vitamin A and B-complex group. Baobab (*Adansonia digitata*) called gonglaiz in Sudan. It has a white pulp inside a hard husk, the pulp is edible and it has a sweet taste and makes a refreshing drink with water. Which contain vitamin C compared to be at least three times higher (150-499 mg/100 g) than common fruit (Manfredini *et al.*, 2002). Godeim (*Grewia tenax*) eaten when it starts to have its dark-orange colour, locally used to make a drink. Godeim is excellent source of iron (Salih, 1991). Pumpkin (*Telfairia occidentalis*) is a tasty source of vitamins and minerals, particularly beta-carotene, vitamin C and potassium. Also it is rich in sodium, iron, phosphorous and Manganese (Egbekun *et al.*, 1998). In pumpkin pulp the amount of protein is negligible - on average 0.8-1.0% (Anonymous, 1976), but they contain almost all the essential and nonessential amino acids (Duke, 1998).

The objectives of this research is to produce high-energy products rich in vitamins and minerals for school-age children, to find out other avenues for the industrial

Corresponding Author: Nawal Abdel-Gayoum Abdel-Rahman, Department of Fruits and Vegetables Technology, Food Research Centre, P.O. Box 213, Khartoum North, Sudan

utilization of fruits and vegetables in Sudan. In addition, reduction of the high incidence of some nutritional problems among Sudanese children and employment of rural, particularly the displaced.

MATERIALS AND METHODS

Mango, baobab, godeim, pumpkin, starch and sugar were obtained from Khartoum North local market. Mangos as well as pumpkin were washed, peeled and cut, then they were pulped using an electric blender machine (model: Reeves, size: IVIF - 18). Baobab and godeim fruits were sorted, washed, soaked in water in ratio 1: 6 for 4 h and 1:8 for overnight, respectively. The soaked fruits were mixed well using an electric stirrer (model: Lightnin, mixer, N.C.-2, USA) and the juice was fine-filtrated through one layer of muslin cloth and kept as juice concentrate form. All these ingredients were processed as paste form and packaged in glass jars (145 g) at the food processing research centre and stored for year at ambient temperature.

Then the paste was analyzed for microbiological analyses, physico-chemical attributes and storage stability every three months.

Microbiological evaluation of the product: This food product was subjected to microbiological analyses to evaluate its safety and to determine the appropriate shelf life. The parameter required for this evaluation include: total bacterial counts, total yeast and moulds, spore-forming, coliform bacteria and *salmonella* spp. According to Harrigan and MacCance (1976).

Physico-chemical attributes and storage stability: The proximate analyses include Total Soluble Solids (TSS), protein, crude fibre, fats, ash and carbohydrates (AOAC, 2000). The pH, total titrable acidity (as citric acid), sugars and vitamin C were determined using the methods described by Ranganna (2001). The caloric values of the paste were calculated by summing the values obtained through multiplying the contents of fats, protein and carbohydrates by the coefficients recorded by IMNA (2002).

Minerals: The minerals were determined according to Ranganna's method (2001) using atomic absorption chromatography (model: Carbolite - Bam ford S30 2 AU. Sheffield, England). Sodium was determined using fame photometer (model: Instrument shimadzu - AA - 6800).

Sensory evaluation: The sensory evaluation included colour, flavour, taste, consistency and overall quality was carried out using methods described by Ali and El-Faki (2006) as follows:

Fifteen panelists (semi trained from the Food Processing Research Centre staff) were presented coded products (under study and control) in glass dishes and asked to evaluate colour, flavour, taste, consistency and overall quality.

The test was carried out in the afternoon period (10:30 to 12:00 AM). The panelists were requested to give the best sample a rank of one and the worst sample a rank of two. The significant difference between the sums of ranks was analyzed at 5 % probability level.

Statistical analysis: Replicates of each sample were analyzed using Statistical Analysis System (SAS). The Randomized Complete Design (RCD) was adopted for this study. The Analysis of Variance (ANOVA) and Least Significant Difference (LSD at 5 %) were used to separate the means according to Mead and Gurnow (1983).

RESULTS AND DISCUSSION

The sample investigated was free from bacterial or fungal contamination throughout storage time.

The proximate analyses and minerals content of raw materials were shown in Tables 1 and 3. The findings of mango fruit were fairy agrees with findings obtained by many researchers (Abdel-Rahman *et al*., 2009; Peter *et al*., 2007; Anila and Radha, 2003; Cunningham *et al*., 2000). Moreover, the results of proximate analysis of baobab were agrees with the findings of Wilkison and Hall, 2007; Buzzoni, 2002; Saka *et al*., 1994; Salih, 1991; Nour *et al*., 1980, whereas, the godeim fruit recorded results are in agreement with Fasoyiro *et al*. (2005); Gebauer *et al*. (2002); Saka *et al*. 1994 and Salih (1991). On the other hand, the pumpkin's proximate analyses were found superior and inferior than the values recorded by Anonymous (2010), Akwaowo *et al*. (2000) and Cunningham *et al*. (2000).

Table 1: Proximate composition (%) of the raw materials

Content	Mango	Baobab	Godeim	Pumpkin
Moisture	85.00	5.27	17.50	90.72
C. Protein	0.74	2.84	5.60	0.75
C. Fibre	2.50	4.36	8.30	0.73
Fat	0.30	0.35	0.52	0.26
Ash	0.92	6.20	4.31	1.09
Carbohydrate	10.54	80.98	63.77	6.45
Vitamin C (mg/100 g)	35.00	345.00	70.25	10.36

The proximate compositions of school-age children paste were presented in Table 2; the paste has moisture content of 67.36%. While the content of crude protein to be 19.36%, according to FAO (2005) 100 grams of this product provided 87.21% for children in ages 4-6 years with 18.2 kg weight. A 75.20% for 7-9 years (52.2 kg), also 46.00% and 40.50% for girls and boys (10-17 years) with weight 46.7 and 49.7 kg, respectively.

The children foods based on fruits and vegetables must contain at least 0.60% fibre (ISHS, 2002), the level of fibre of this product was found 3.13%. Moreover, the fat and ash contents of the product were 3.06% and 10.20%. The product was found to be rich in vitamin C; it is provided 28.85, 15.25 and 10.45%/day from

Table 2: Proximate composition (%) of fruit paste on dry base

Moisture	Crude protein	Crude fibre	Fat	Ash	Carbo-hydrate	Vitamin C (mg/100 g)	Energy (kcal/100 g)
67.36	19.36	3.13	3.06	10.20	64.25	575.06	365.24

Table 3: Minerals content (mg/100 g) of the raw materials and fruit paste

Mineral	Mango	Baobab	Godeim	Pumpkin	Paste
Iron (Fe)	0.55	1.50	7.34	3.20	3.63
Zinc (Zn)	0.07	1.37	1.98	3.90	0.20
Calcium (Ca)	0.30	250.00	595.00	14.25	109.00
Sodium (Na)	25.06	8.00	9.72	1.63	2.00
Phosphorous (P)	16.20	65.00	85.00	46.12	38.00
Potassium (K)	207.00	2500.00	1400.00	315.00	2400.00
Magnesium (Mg)	1.44	153.00	167.00	23.25	85.00

Table 4: The changes in physiochemical composition of fruits paste during stored at ambient temperature*

	Storage period (months)						
Parameter	0	3	6	9	12	$LSD_{0.05}$	SE±
TSS (%)	33.00^{a}	32.30^{a}	33.00^{a}	33.00^{a}	33.50^{a}	1.629	0.517
pH	3.80^{b}	3.66^{e}	3.68^{d}	3.74^{c}	3.86^{a}	0.0005753	0.0001826
Acidity** (%)	0.42^{a}	0.35^{b}	0.35^{b}	0.33^{c}	0.31^{d}	0.0005753	0.0001826
Total sugars (%)	32.50^{c}	31.34^{d}	31.17^{e}	32.85^{b}	33.21^{a}	0.08136	0.02582
Reducing sugars (%)	2.85^{e}	3.48^{d}	3.92±1.97^{c}	4.14^{b}	4.46^{a}	0.0005753	0.0001826
Sucrose (%)	28.17^{a}	25.53^{c}	27.12^{b}	27.94^{a}	28.00^{a}	0.8136	0.2582
Vitamin C (mg/100 g)	187.70^{a}	162.19^{b}	147.88^{c}	139.00^{d}	135.54^{e}	0.8177	0.2595

*Means±SD having different superscript letters in columns and rows are significantly different ($p \leq 0.05$). **As citric acid

recommended needs of vitamin C for school children (4-8, 9-13 years) and adults (14-18 years), respectively (IM, 2001). On the other hand, compared with FAO/WHO (2004) this school age paste (100 g) to be rich in ascorbic acid, it provided of 34.38%, 21.28%, 10.05% and 9.44% of vitamin C for (4-6 years), (7-9 years), (10-17 years girls and boys), respectively.

Young children do not have the capacity to eat large quantities of food, so they need small and frequent meals. Their diet should not contain too many foods that are bulky or watery. This product (100 g) contains about 365.00 kcal/100 g, this level is supplying about 27.00, 21.50, 16.00 and 13.00% of daily requirement of energy for children in ages 4-6, 7-9 and 10-17 years (girls and boys), respectively (FAO, 2005).

Table 3 shows the mineral contents of the fruit paste. The table shows that the product supply high percentage of some minerals for children (4-8 years), male and female (9-13 years) and adults (male and female, 14-18 years). Food fortification with iron is recommended when dietary iron is insufficient or the dietary iron is of poor bio-availability (WHO/ FAO, 1996), each 100 g of product supplying of 36.30%, (45.38, 33.00%) and (45.38, 41.25%) of iron for children ages, respectively. As well as, according to the last reference, the body depends on a regular zinc supply provided by the daily diet because stores are quite limited. So, each 100 g provided of 4%, (2.5, 1.8%) and (2.5, 2.2%) of Zinc, respectively (IM, 2001). On the other hand, according to the FAO/WHO (2004) this paste is supplying 3.32 % for (4-6 years), 1.60% for (7-9 years) and 0.56%, 0.43% (10-17 years, girls, boys, respectively) of iron. CODEX/FAO/WHO (2009) reported the minimum level of zinc per 100 kcal to be 0.5 mg, referred to that; 100 kcal of the product were providing only 10.00% of zinc metal.

Therefore, the fruit paste containing of 13.00% and 8.38% of calcium, 16.67 and 13.33% of sodium, 0.67% for children (4-8 years) and the other ages, respectively. Also, the paste containing 41.56% (minimum level) and 11.48% (maximum level) of phosphorous per 100 kcal (CODEX/FAO/WHO, 2004). Whereas, each 100 g of the product contain quantity equal to 18.17% (4-6 years), 15.57% (7-9 years) and 8.38% (10-18 years) from recommended daily intakes of calcium (FAO/WHO, 2004). The product under study is poor in sodium element, it supplied only 1.0% when compared to minimum level per 100 kcal (CODEX/FAO/WHO, 2009). The potassium and magnesium were found abundant than maximum and minimum needed for the physiological needs of school age children an envisaged by the CODEX/FAO/WHO (2004) recommendations.

Table 4 shows the changes in physico-chemical composition during storage. There is no Significant difference ($p \leq 0.05$) in TSS% during stored at ambient temperature. Furthermore, there were a slight increased and decreased in pH and total acidity, respectively in the same conditions. The total and reducing sugars were increased from 32.50 and 32.50% to 33.21 and 4.46%, respectively; this increase may be due to the hydrolysis of starch. Therefore, Significantly ($p \leq 0.05$) no change in sucrose content between initial value (28.17%) and last

Table 5: Sensory evaluation of fruits paste*

	Character				
Sample	Colour	Flavour	Taste	Consistency	Overall quality
A	25.00±5.33[a]	30.00±6.18[a]	27.00±6.08[a]	24.00±5.18[a]	28.00±6.13[a]
B	20.00±4.87[b]	15.00±3.33[b]	18.00±4.19[b]	21.00±4.62[b]	17.00±4.07[b]
$Lsd_{0.05}$	4.1587	12.5196	6.5984	2.3214	10.9546
SE±	2.5671	7.6301	3.0609	0.9657	5.1232

*Means±SD having different superscript letters in columns and rows are significantly different ($p \leq 0.05$). A: School-age children paste. B: Control paste from local market

value (28.00%) at the end of storage, the losses in vitamin C during storage were reached to 27.29%.

Table 5 shows the sensory evaluation of the fruits paste and control. The fruit paste was acceptable for colour, flavour, taste, consistency and overall quality.

Generally, it could be concluded that uses of local common fruits, vegetables with forest fruit helps in providing some nutrients and energy to children and adults between 4-18 years.

REFERENCES

Abdel-Rahman, N.A., A.E. Ali and E.A. Abdel Rahman, 2009. Physico-chemical evaluation of mango fruits from trees raised from seeds. Alzaiem Alazhri University. The Scientific J. (Sudan), 7: 119-132.

Akwaowo, E.U., B.A. Ndon and E.U. Etuk, 2000. Minerals and antinutrients in fluted pumpkin (*Telfairia occidentalis* Hook f.). J. Food Chem., 70: 235-240.

Ali, M.A. and A.E. El-Faki, 2006. A comparison between a traditional and an advanced decortication method on the nutrients of sorghum (*Sorghum bicolor* L. Moench) grains. J. Food Sci. Technol. (Sudan), 1:3 1-43. (Cited from Ihekoronye, N.I. and Ngoddy, P.O., 1985. Integrated food science and technolgy for the tropics. 1st Edn., pp: 180, 181. MacMillan Publisher. London).

Anila, R. and T. Radha, 2003. Physico-chemical analysis of mango varieties under keral condition. J. Trop. Agric., 41: 20-22.

Anonymous, 2010. Nutritional value of pumpkin. Available in: www.answers.com.

Anonymous, 1976. Common vegetables for seed and fruit. Pumpkin and squash, pp: 1-7. Available in: http://www.beeculture.com/content/pollination_handbook/pumpkin.html.

AOAC, 2000. Association of Official Agriculture Chemist. Official Methods of Analysis. Assoc. of Analytical Chemist. 17th Edn., Gaithersburg, DW. Washington. DC. USA.

Berez, F.L., A.L. Saguilan, M.G. Montealvo, S.G. Feria and F.E. Huicohea, 2005. Isolation and characterization of mango (*Mangifera indica* L.). Starch: Morphology, physicochemical and functional studies. Plant Food Human Nutr., 60: 7-12.

Buzzoni, V., 2002. Antioxidant capacity of *Adonsonia digitata* fruit pulp and leaves. Acta Phtotherapeutica, 2: 2-7. published Nicol, B.M.

CODEX/FAO/WHO, 2009. CODEX alimentarius commission joint FAO/WHO Standard programme committee on nutrition and dietary uses. 31st session. Report Shuman Hall, Museum Kunst Palast, Dusseldort, Germany.

CODEX/FAO/WHO, 2004. CODEX alimentarius commission joint FAO/WHO food standard programme report of the 25th session of the Codex committee on nutrition and food for special dietary uses. Bonn, Germany.

Cunningham, J.H., G. Milligan and L. Trevisan, 2000. Minerals in Australian fruits and vegetables: A comparison of levels between the 1980s and 2000. Food Standard. Australia New Zealand.

Duke, J.A., 1998. Dr. Duke's Phytochemical and ethnobotanical databases. http://www.ars-grin.gov/cgi-bin/duke/farmacy2.pl?327.

Egbekun, M.K., E.O. Nda-Suleiman and O. Akinyeye, 1998. Utilization of fluted pumpkin fruit (*Telfairia occidentalis*) in marmalade manufacturing. J. Plant Foods Human Nutr., 52: 171-176.

Fasoyiro, S.B., S.O. Babalola and T. Owosibo, 2005. Chemical composition and sensory quality of fruit-flavoured roselle *(Hibiscus sabdariffa*) drinks. World J. Agric. Sci., 1: 161-164.

FAO, 2005. Setting up and running a school garden: Daily recommended for energy and nutrients. Food and Agriculture Organization of the United Nations. Rome, Italy.

FAO/WHO, 2004. Vitamin C and minerals requirements in human nutrition. 2nd Edn., Joint FAO/WHO World Health Organization and Food and Agriculture Organization of the United Nations. Bankok, Thailand.

Gebauer, J., K. El-Sidig, B.A. El-Tahir, A.A. Salih, G. Ebert and K. Hammer, 2002. Exploiting the potential of indigenous fruit trees: Grewia tenax (Forssk.) fiori in Sudan. J. Genat. Resour. Crop Evol., 54: 1701-1708.

Harrigan, W.F. and M. MacCance, 1976. Laboratory Methods in Food and Dairy Microbiology, 1st Edn., pp: 139-150, 384, Academic Press Inc, London.

IM, 2001. Dietary reference intakes for vitamin C, iron and zinc. Institute of Medicine. National Academy Press. Washington, DC. USA.

IMNA, 2002. Institute of Medicine of the National Academies. The National Academies Press. Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein and amino acids. Washington, DC. USA.

ISHS, 2002. Chronica horticultural. Int. Soc. Hortic. Sci., 42: 1-52.

Manfredini, S., S. Vertuani, E. Braccioli and V. Buzzoni, 2002. Antioxidant capacity of *Adonsonia digitata* fruit pulp and leaves. Acta Phytotherapeutica, 2: 2-7. Pub. Nicol, B.M.

Mead, B. and R.W. Gurnow, 1983. Statistical methods in agricultural experimental biology, London, New York, Chapman and Hall.

Nour, A.A., B.I. Nagboul and N.H. Kheiri, 1980. Chemical composition of baobab fruit (*Adansonia digitata* L.). Rivista Italiana Delle Grasse, 73: 371-388.

Oyeleke, O.A., L.D. Morton and A.E. Bender, 1985. The use of cowpeas (*Vigna unguiculata*) in improving a popular Nigerian weaning food. Br. J. Nutr., 54: 243-347.

Peter, M., F. Leonard, C. Bernard, K. Joyce, G. Victor and M. Kaswija, 2007. Physical and chemical characteristics of off vine ripened mango (*Mangifera indica* L.) fruit (Dodo). Afr. J. BioTechnol., 6: 2477-2483.

Ranganna, S., 2001. Proximate analysis, color measurement and sensory evaluation. In Handbook of analysis and quality control of fruits and vegetable products, Tata McGraw Hill Co. Ltd., New Delhi, India.

Saka, J.D.K., J.D. Msonthi and J.A. Magherube, 1994. The nutritional value of edible fruits of indigenous wild trees of Malawi. Forest Ecol. Manage., 64: 245-248.

Salih, O.M., 1991. Biochemical and Nutritional Evaluation of Famine Foods of the Sudan. PhD Thesis. University of Khartoum, Sudan.

VS, 2010. Vegetarian nutrition for children (part 2): The School Age Child (Age 5-12): School meals: Important Nutrients. Vegetarian Society. Available in: http://www.vegsoc.org/.

WHO, 2003. Global database on child growth and malnutrition forecast and trends document. WHO/NHD. World Health Organization of the United Nations. Geneva, Switzerland.

WHO/FAO, 1996. Preparation and use of food-based dietary Guidelines. Report of a joint FAO/WHO consultation, Nicosia, Cyprus 1996. Nutrition Program, World Health Organization, Geneva, Switzerland. WHO/NUT/96.6.

Wilkison, J. and M. Hall, 2007. Baobab fruit: The upside down tree could turn around the drinks industry. Botanicals Soft Drink International, pp: 26, 27, 28. Available in: http://www.phytotradeafrica.com.